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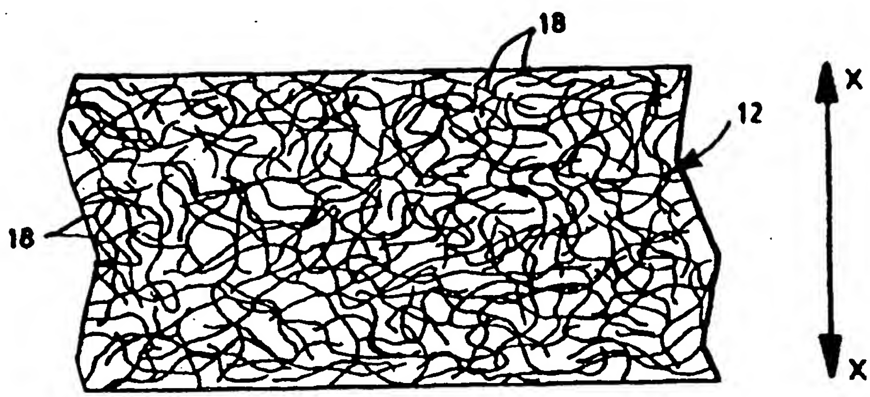
(54) Title: ADHESIVELY-REINFORCED, ORIENTED, LOW GAUGE, BREATHABLE FILM

(57) Abstract

The present invention is directed to an adhesively-reinforced, uniaxially oriented, low gauge (stretch-thinned) breathable film onto which a pattern or network of adhesive areas is applied to improve durability and strength of the film. The present invention has applicability in a wide variety of areas where strength, comfort, liquid impermeability and breathability are needed or desired, including without limitation, personal care absorbent articles.



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ADHESIVELY-REINFORCED, ORIENTED, LOW GAUGE, BREATHABLE FILM

This application claims priority from US Provisional Application no. 60/021,732 filed July 15, 1996.

FIELD OF THE INVENTION

The present invention is directed to oriented, low gauge, breathable films.

BACKGROUND OF THE INVENTION

Film materials have found widespread use in a wide variety of applications, including outer covers for personal care absorbent articles, such as diapers, training pants, incontinence garments, feminine hygiene products, sanitary napkins, wound dressing, bandages, and the like. Such film materials also have been found useful in consumer and industrial packaging.

Particularly in the field of personal care absorbent articles, an emphasis has been placed on development of low cost materials for incorporation in such articles, without sacrificing performance. In the case of film materials used as outer covers, such materials must form an effective barrier to passage of body exudates (liquids and other waste matter), while exhibiting satisfactory aesthetic and tactile properties, such as hand and feel. One technique employed in attempting to achieve a satisfactory, low cost film material has been to use films of increasingly lesser gauge or thickness. Thinner films typically are lower in cost, and due to the reduced gauge, often have increased softness and are quieter during use. Such lower gauge films also can be rendered breathable or microporous more easily.

Such thin films can have an effective gauge or thickness of 0.6 mil or less and a basis weight of 25.0 grams per square meter (gsm) or less. Particularly when such low gauge films are achieved by drawing or stretching, such as in the machine direction, the drawing or stretching orients the molecular structure of the polymer molecules within the film in the direction of stretching, thereby increasing the strength of the film in the machine direction. However, the same machine direction oriented film is weakened in the cross direction in terms of tensile strength and trap tear properties.

In order to compensate for structural weaknesses in such uni-directionally stretched films, a support layer (or multiple support layers), such as a fibrous nonwoven web, has been laminated to the film layer to form a laminate having, among other properties, increased strength and durability. Laminates of low-gauge or stretch-thinned films and nonwovens have been formed using thermal lamination techniques, in which heat and pressure, as with heated pattern rolls and ultrasonics, have been employed. Such thermal lamination may require a level of heat and pressure that results in undesired perforations in or localized film damage to the film layer, and/or in the resultant laminate being undesirably stiff. Such thermally laminated film-nonwoven laminates have in some instances, particularly when employed as an outer cover for personal care absorbent articles, exhibited insufficient strength and durability properties, resulting in catastrophic tear failures of the film layer of the laminate during use of such absorbent articles. The inventors have observed that in such thermally laminated film-nonwoven laminates, tear failures of thermally laminated film-nonwoven laminates tend to propagate from thermal bond points or areas in which the film and nonwoven layers are bonded together. Accordingly, the need exists for an improved uniaxially (i.e., machine direction) oriented, low gauge film having enhanced strength and durability properties, particularly in the cross machine direction.

SUMMARY OF THE INVENTION

It is an object, therefore, of the present invention to provide an improved uniaxially oriented, low gauge film having enhanced strength and durability properties by applying to a surface thereof a pattern or network of adhesive areas.

It is another object of the present invention to provide an improved, low cost, adhesively-reinforced film having enhanced strength and durability properties, and that is highly breathable.

These and other objects are achieved by the adhesively-reinforced, uniaxially oriented, low gauge film material of independent claim 1, which comprises:

a film layer having a surface;

said film layer being oriented in a direction of stretching and having an effective gauge of 0.6 mil or less;

said film layer being formed from a blend including, on a total weight percent basis based upon the total weight of the film layer, from about 30 percent to about 70 percent of a first polyolefin polymer, from about 70 percent to about 30 percent of a filler, and from about 0 to about 20 percent of a second polyolefin polymer;

said film layer having a water vapor transmission rate of at least about 300 grams per square meter per 24 hours;

a pattern of adhesive areas applied to said surface of said film layer;

said pattern of adhesive areas having an add-on amount of from about 0.1 to about 20 grams per square meter (gsm), a percent bond area of from about 5 percent to about 50 percent per unit area of said surface of said film layer, and a maximum spacing between adhesive areas in a direction generally parallel to said direction of stretching of about 1.0 inch or less.

Other advantageous features, aspects and details of the present invention are evident from the dependent claims, the description and the drawings herein. The claims herein are intended to be understood as a first non-limiting approach to defining the present invention in general terms.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an elevational view of a random pattern of meltblown adhesive fibers applied to a surface of a film layer according to the present invention, in which the direction of stretching of the film layer is indicated by line x-x.

Figure 2 is an elevational view of a ribbed pattern of printed pigmented adhesive areas applied to a surface of a film layer according to the present invention, in which the direction of stretching of the film layer is indicated by line x-x.

Figure 3 is an elevational view of a cloud pattern of printed pigmented adhesive areas applied to a surface of a film layer according to the present invention, in which the direction of stretching of the film layer is indicated by line x-x.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The present invention is directed to an improved, adhesively-reinforced, uniaxially oriented, low gauge film material which utilizes a pattern or network of adhesive areas applied to a surface of the film layer to improve durability and strength of the uniaxially, typically machine direction, oriented film. Referring to Figure 1, an embodiment of the adhesively-reinforced film material of the present invention is illustrated. The adhesively-reinforced film material comprises a uniaxially oriented, low gauge film layer 12 having a surface 14 onto which is applied a pattern or network of adhesive fibers, filaments, lines or areas 18. Adhesive areas 18 have a percent bond area of from about 5 percent to about 50 percent per unit area of the surface 14 of the film 12, and have a maximum spacing between adhesive areas 18 in a direction generally parallel to the direction of stretching (orientation) of no more than about 1.0 inch (about 25.4 millimeters (mm)). The adhesive 18 is applied to a surface 14 of the film layer 12 at an add-on amount ranging from about 0.1 to about 20 grams per square meter (gsm).

As used herein, the term "layer" when used in the singular can have the dual meaning of a single element or a plurality of elements. As used herein, the term "machine direction" or MD means the length of a material in the direction in which it is produced. The term "cross machine direction" or CD means the width of a material, i.e., a direction generally perpendicular to the MD.

Film layer 12 includes at least two basic components: a polyolefin polymer, advantageously a predominately linear polyolefin polymer, such as linear low density polyethylene (LLDPE) or polypropylene, and a filler. These components are mixed together, heated and then extruded into a film layer using any one of a variety of film-producing processes known to those of ordinary skill in the film processing art. Such film-making processes include, for example, cast embossed, chill and flat cast, and blown film processes. Other additives and ingredients may be added to the film layer 12 provided they do not significantly interfere with the ability of the film layer to function in accordance with the teachings of the present invention.

Generally, on a dry weight basis, based on the total weight of the film, the film layer 12 will include from about 30 to about 70 weight percent of the polyolefin polymer, and from about 30 to about 70 weight percent of the filler. In more specific embodiments,

it may include in addition from about 0 to about 20 percent by weight of another polyolefin polymer, such as low density polyethylene.

Linear low density polyethylene has been found to work well as a film base when blended with appropriate amounts of a filler. It is believed, however, that any suitable polyolefin polymer can be used in forming the film layer 12 of the present invention, and advantageously any predominately linear polyolefin polymer can be used in forming the film layer 12 of the present invention. As used herein, the term "linear low density polyethylene" is meant to include polymers of ethylene and higher alpha olefin comonomers such as C_3 - C_{12} and combinations thereof and has a Melt Index (MI) as measured by ASTM D-1238 Method D of from about 0.5 to about 10 (grams per 10 minutes at 190 degrees Celsius (°C)). By "predominately linear" it is meant that the main polymer chain is linear with less than approximately 5 long chain branches per 1000 ethylene units. Long chain branches would include carbon chains greater than C_{12}. For predominately linear polyolefin polymers that are nonelastic, short chain branching (C_3 - C_{12}) due to comonomer inclusion will typically be limited to less than 20 short chains per 1000 ethylene units and 20 or greater for polymers which are elastomeric. Examples of predominately linear polyolefin polymers include, without limitation, polymers produced from the following monomers: ethylene, propylene, 1-butene, 4-methyl-pentene, 1-hexene, 1-octene and higher olefins as well as copolymers and terpolymers of the foregoing. In addition, copolymers of ethylene and other olefins including butene, 4-methyl-pentene, hexene, heptene, octene, decene, etc., would also be examples of predominately linear polyolefin polymers.

In addition to the polyolefin polymer, the film layer 12 also includes a filler. As used herein, a "filler" is meant to include particulates and other forms of materials which can be added to the film polymer extrusion blend and which will not chemically interfere with the extruded film but which are able to be uniformly dispersed throughout the film. Generally, the fillers will be in particulate form and may have a spherical or non-spherical shape with average particle sizes in the range of about 0.1 to about 7 microns. Both organic and inorganic fillers are contemplated to be within the scope of the present invention provided that they do not interfere with the film formation process, or the ability of the film layer to function in accordance with the teachings of the present invention. Examples of suitable fillers include calcium carbonate ($CaCO_3$), various kinds of clay, silica (SiO_2), alumina, barium carbonate, sodium carbonate, magnesium carbonate, talc, barium sulfate,

magnesium sulfate, aluminum sulfate, titanium dioxide (TiO_2), zeolites, cellulose-type powders, kaolin, mica, carbon, calcium oxide, magnesium oxide, aluminum hydroxide, pulp powder, wood powder, cellulose derivatives, chitin and chitin derivatives. A suitable coating, such as, for example, stearic acid, may also be applied to the filler particles, as desired.

As mentioned herein, film layer 12 may be formed using any one of the conventional processes known to those familiar with film formation. The polyolefin polymer and filler are mixed in appropriate proportions given the ranges outlined herein and then heated and extruded into a film. In order to provide uniform breathability as reflected by the water vapor transmission rate of the film, the filler should be uniformly dispersed throughout the polymer blend and, consequently, throughout the film layer itself. For purposes of the present invention, a film is considered "breathable" if it has a water vapor transmission rate of at least 300 grams per square meter per 24 hours ($g/m^2/24$ hrs) as calculated using the test method described herein. Generally, once the film is formed, it will have a weight per unit area of less than about 80 grams per square meter (gsm) and after stretching and thinning, its weight per unit area will be from about 12 grams per square meter to about 25 grams per square meter.

The film layers used in the examples of the present invention described below were monolayer films, however, other types, such as multi-layer films, are also considered to be within the scope of the present invention provided the forming technique is compatible with filled films. The film as initially formed is generally thicker and noisier than desired, as it tends to make a "rattling" sound when shaken. Moreover, the film does not have a sufficient degree of breathability as measured by its water vapor transmission rate. Consequently, the film is heated to a temperature equal to or less than about 5 °C below the melting point of the polyolefin polymer and then stretched using an in-line machine direction orientation (MDO) unit to at least about two times (2X) its original length to thin the film and render it porous. Further stretching of the film layer 12, to about three times (3X), four times (4X), or more, its original length is expressly contemplated in connection with forming film layer 12 of the present invention.

Film layer 12 after being stretch-thinned should have an "effective" film gauge or thickness of from about 0.2 mil to about 0.6 mil. The effective gauge is used to take into consideration the voids or air spaces in breathable film layers. For normal, non-filled, non-

breathable films, the actual gauge and effective gauge of the film will typically be the same. However, for filled films that have been stretch-thinned, as described herein, the thickness of the film will also include air spaces. In order to disregard this added volume, the effective thickness is calculated according to the test method set forth herein.

An additional feature of the stretch-thinning process is the change in opacity of th film material. As formed, the film is relatively transparent, however, after stretching the film becomes opaque. In addition, while the film becomes oriented during the stretch-thinning process, it also becomes softer and the degree of "rattling" is reduced.

Such uniaxially, machine direction oriented films typically do not have good strength properties in the cross machine direction, resulting in films that are easily torn or split along the machine direction (the direction of stretching). The inventors have discovered that by applying a network or pattern of adhesive areas as defined herein to a surface of such a film, strength and durability of the film material can be enhanced.

The term "adhesive" as used herein is intended to refer to any suitable hot melt, water or solvent borne adhesive that can be applied in the required pattern or network of adhesive areas to form the adhesively-reinforced, uniaxially oriented, low gauge film of the present invention. Accordingly, suitable adhesives include conventional hot melt adhesives, pressure-sensitive adhesives and reactive adhesives (i.e., polyurethane). More specifically, block copolymer-type construction adhesives, ethylene vinyl acetate (EVA)-based adhesives (e.g., 18 - 30 weight percent vinyl acetate) and amorphous alphaolefin copolymer and terpolymer-based adhesives have been found to work well in forming the adhesively-reinforced, uniaxially oriented, low gauge film of the present invention. All such adhesive types can be formulated to contain waxes and tackifiers to improve processing or hot tack or softness.

The adhesive application process employed must be suited to the particular type of adhesive used, and to the particular end use application for which the adhesively-reinforced, uniaxially oriented, low gauge film is intended. The adhesive can be applied, for example, in a pattern or network of intersecting, randomly dispersed meltblown adhesive fibers. Such meltblown adhesive fibers typically have average diameters in the range of from about 5 microns to about 50 microns. As used herein, the term "meltblown adhesive fibers" is intended to include both discontinuous and continuous adhesive fibers. Processes for applying meltblown fibers onto the surface of a moving substrate are

known, as exemplified by U.S. Pat. No. 4,720,252 to Appel et al., the disclosure of which is incorporated herein by reference.

Other suitable processes for applying adhesive to the film layer 12 include, for example, sprayed or swirled hot melt adhesive areas, and screen or gravure printing of adhesive areas. Such melt spraying and adhesive printing processes are well known in the art and are, therefore, not described in detail herein. Application of adhesives, particularly pigmented adhesives, using such printing processes offers additional aesthetic benefits, as the adhesive pattern can be in the form of geometric or non-geometric and repeating or non-repeating shapes, continuous or discontinuous lines, fanciful or arbitrary designs, symbols or objects, or even text or words. The adhesive patterns shown in Figures 2 and 3 are illustrative of such printed adhesive patterns.

Certain printing processes, such as screen printing, require direct contact between the screen and the substrate being printed. Printing certain types of adhesives, such as some pressure sensitive adhesives, can prove problematic due to the high tack or level of adhesion of such adhesives at ambient temperature. Screen printing of such adhesives can be accomplished, however, by printing the adhesive onto a suitable release surface, such as, for example, a release paper, and then transferring the printed adhesive onto the film layer 12 from the release surface.

The adhesive application process employed to apply adhesive 18 to surface 14 of film layer 12 must be capable of effectively controlling the amount of adhesive available for film layer reinforcement, and the adhesive application pattern. Moreover, application of adhesive 18 should be substantially coextensive with the length and width of film layer 12, in order to ensure uniformity in strength and durability properties of the adhesively-reinforced film.

A primary function of the adhesive areas is to reinforce the low gauge or stretch-thinned film layer of the present invention. As noted herein, films that are highly oriented (2X or more) in the machine direction (MD) tend to be "splitty" in the machine direction when subjected to cross machine direction (CD) tensile forces. The inventors have observed that a randomly dispersed, intersecting network of meltblown adhesive areas applied to such a film in accordance with the present invention works particularly well in providing a "rip-stop" against such film splitting by distributing CD tensile loads applied to

the film, thereby enhancing the durability and strength of such machine direction oriented films. More specifically, the network of randomly dispersed, intersecting meltblown adhesive areas includes individual meltblown adhesive fibers that are "closely spaced" in the MD. As used herein, the term "closely spaced adhesive areas" refers to adhesive areas that are separated by a maximum distance between individual adhesive areas of about 1.0 inch (25.4 mm) in a direction generally parallel to the direction of stretching, and more specifically a maximum distance of 0.25 inch (6.35 mm), and even more specifically a maximum distance of 0.125 inch (3.18 mm). As used herein, the term "generally parallel to the direction of stretching" means a line along which the distance between adhesive areas is measured will have an interior angle with a line in the direction of stretching of less than or equal to 30°. By limiting the maximum spacing between individual adhesive areas in the direction of stretching of the film layer, for example, the machine direction, to the specified range, the formation and propagation of holes or tears in film layer 12 is reduced, and the amount of elongation in the cross machine direction the film layer 12 can withstand before splitting or tearing is increased. Stated alternatively, by increasing the connectivity and proximity of individual adhesive areas within the adhesive pattern or network, splittiness of film layer 12 is effectively reduced.

Although a randomly dispersed, intersecting network of adhesive areas, such as meltblown adhesive fibers, can be effectively utilized in forming the adhesively-reinforced, uniaxially oriented, low gauge film of the present invention, as noted herein, other adhesive application patterns and methods can be employed as well. For example, generally parallel, continuous and/or discontinuous, adhesive lines extending or oriented in the cross machine direction and printed onto surface 14 of film layer 12 at an add-on amount and percent bond area within the ranges specified herein can impart the desired increase in strength and durability to film layer 12. Use of suitable adhesive application methods is limited by their capacity to control the add-on amount of adhesive used, percent bond area of the adhesive areas, and the maximum spacing between individual adhesive areas in the direction of stretching (MD). The adhesive add-on amount should range from about 0.1 to about 20 grams per square meter, and more specifically from about 0.25 to about 5.0 grams per square meter , and even more specifically from about 0.5 to about 1.5 grams per square meter. Reducing the add-on amount lowers the cost of producing the adhesively-reinforced, uniaxially oriented, low gauge film, and reduces the risk of compromising breathability of the film layer. By way of contrast, higher add-on amounts of adhesive provide more durable film materials.

By applying a pattern or network of adhesive areas as described herein, as compared to a continuous coating of adhesive, for example, the microporosity or breathability of the film material is not significantly reduced. The portion of the total area of surface 14 of the film layer 12 to which adhesive areas 18 are applied can be expressed as a percent bond area. The term "percent bond area" as used herein refers to the portion of the total plan area of surface 14 of the film layer 12 that is occupied by adhesive areas 18. The percent bond area can be measured by a variety of conventional techniques, including imaging analysis as described herein. By limiting the percent bond area of the adhesive areas to a range of from about 5 percent to about 50 percent per unit area of the surface 14 of film layer 12 to which the adhesive areas are applied, and controlling the maximum spacing of adhesive area application, as well as the adhesive add-on amount, adhesive reinforcement of low gauge, stretch-thinned breathable filled films can be accomplished without adversely impacting the breathability of the film material.

Although the primary function of the adhesive areas 18 is to reinforce the low gauge or stretch-thinned film layer 12 of the present invention, the type of adhesive utilized can be appropriately selected to impart additional functionality to the adhesively-reinforced, uniaxially oriented, low gauge film of the present invention. For example, the adhesive can be selected so that it has sufficient open time, that is, remains tacky for a sufficient time to allow the adhesive 18 also to bond surface 14 of the film layer 12 to a surface of an adjacent layer, such as a nonwoven web or fabric. As used herein, the terms "nonwoven web" or "nonwoven fabric" mean a web having a structure of individual fibers or filaments that are interlaid, but not in an identifiable, repeating manner as in a knitted or woven fabric. Nonwoven webs can be formed by a variety of known forming processes, including spunbonding, airlaying, meltblowing, or bonded carded web formation processes. Other examples of suitable adjacent layers to which surface 14 of film layer 12 could be adhesively bonded include woven and/or knitted fabrics, and foam or tissue layers.

In addition, although the adhesively-reinforced film material of the present invention has been described herein as uniaxially stretched or oriented, the benefits and advantages of the present invention can apply to biaxially stretched or oriented films as well. Likewise, although application of adhesive areas 18 to a surface 14 of the film layer 12 has been described herein, adhesive areas also can be applied to a surface opposing surface 14 of the film layer 12, wherein adhesive areas on the opposing surfaces of film

layer 12 are identical or different in terms of add-on amount, percent bond area and maximum spacing in the direction of stretching.

Having described the above embodiments of the present invention, a series of sample adhesively-reinforced, uniaxially oriented, low gauge films were formed to further illustrate the present invention. The results of these tests, and the test procedures used, are set forth

TEST PROCEDURES

The following test procedures were used to analyze the sample materials described herein.

Effective Gauge

The effective gauge of a film material was calculated by dividing the basis weight of the film by the density of the polymer(s) and fillers forming the film. To obtain the effective gauge of a film material in units of inches, the weight per unit area measured in ounces per square yard (osy) was multiplied by 0.001334 (a metric to English conversion factor) and the result was divided by the density of the polymer formulation in grams per cubic centimeter (g/cc).

Tensile Strength and Elongation Tests

The strip test method for tensile strength and elongation measures the breaking load and percent elongation before rupture of a material. These measurements are made while the material is subjected to a continually increasing load in a single direction at a constant rate of extension.

For each sample film material, 3 specimens were cut with a 3 inch (76 mm) wide precision cutter, with each having a width of 3 inches (76 mm) and length of 6 inches (152 mm), with the long dimension parallel to the direction of testing and force application. The entire width of each specimen was placed within clamps of a constant-rate-of-extension tester, such as a Sintech System 2 Computer Integrated Testing System manufactured by MTS Systems Corporation of Eden Prairie, Minnesota. The length or long dimension of

each specimen was set as nearly parallel as possible to the direction of force application. A continuous load was applied to the specimen, with the crosshead speed set at 300 millimeters per minute, until the specimen ruptured. The peak load and peak strain required just prior to rupture of each specimen was measured and average values are recorded herein.

Water Vapor Transmission Rate

The water vapor transmission rate (WVTR) for the sample materials was calculated in accordance with ASTM Standard E96-80. Circular samples measuring three inches in diameter were cut from each of the test materials and a control, which was a piece of CELGARD® 2500 film from Hoechst Celanese Corporation of Sommerville, New Jersey. CELGARD® 2500 film is a microporous polypropylene film. Three samples were prepared for each material. The test dish was a number 60-1 Vapometer pan distributed by Thwing-Albert Instrument Company of Philadelphia, Pennsylvania. One hundred milliliters (ml) of distilled water was poured into each Vapometer pan and individual samples of the test materials and control material were placed across the open tops of the individual pans. Screw-on flanges were tightened to form a seal along the edges of each pan (no sealant grease is used), leaving the associated test material or control material exposed to the ambient atmosphere over a 6.5 centimeter (cm) diameter circle having an exposed area of approximately 33.17 square centimeters. The pans were weighed, then were placed in a forced air oven set at a temperature of 37 °C. The oven was a constant temperature oven with external air circulating through it to prevent water vapor accumulation inside. A suitable forced air oven is, for example, a Blue M Power-O-Matic 60 oven distributed by Blue M Electric Company of Blue Island, Illinois. After 24 hours, the pans were removed from the oven and weighed again. The preliminary test water vapor transmission rate values were calculated as follows:

Test WVTR = (grams weight loss over 24 hours) x 315.5
$g/m^2/24$ hrs

The relative humidity within the oven was not specifically controlled.

Under predetermined set conditions of 100 degrees Fahrenheit (°F) (32 °C) and ambient relative humidity, the WVTR for the CELGARD® 2500 film control has been

determined to be 5000 grams per square meter for 24 hours. Accordingly, the control sample was run with each test and the preliminary test values were corrected to set condition using the following equation:

$$\text{WVTR } g/m^2/24\text{ hrs} = (\text{Test WVTR/control WVTR}) \times 5000\ g/m^2/24\text{ hrs})$$

Adhesive Bond Area Test/Maximum Spacing Test

The adhesive bond area test measures the portion of a unit area of a surface of the film layer to which a pattern of adhesive areas is applied. The maximum spacing test measures the maximum free path measurement between adhesive areas in the direction of stretching of the film.

Four to six specimens of 5 - 6 square inches (32 - 39 square centimeters) were cut from each sample material tested. Each specimen was placed in a small tin and stained with osmium tetroxide (OsO_4) vapors by placing the specimen in a glass dessicator having a liquid volume of approximately one gallon (3.785×10^{-3} cubic meters) for a period of 16 hours. The osmium tetroxide was supplied by Ted Pella, Inc. of Redding, CA. The osmium tetroxide was not dissolved in water.

The stained laminates were peeled open by hand, leaving the stained adhesive on a surface of the film layer of each laminate. The osmium tetroxide de-tackifies and cross-links (strengthens) the adhesive, facilitating delamination of the film and nonwoven layers.

The stained adhesive was imaged in reflected light using a Wild M420 macro instrument available from Leica of Deerfield, Illinois, with a FOSTEC fiber optic ringlight. Images were acquired through an Model CCD-72 monochrome camera system available from Dage MTI of Michigan City, Indiana, directly into a Princeton Gamma Tech (of Princeton, New Jersey) Imagist™ system. The video camera manual controls were used, so that there was no variation in image density due to automatic gain control compensation. The images were thresholded, binarized and analyzed using Princeton Gamma Tech image analysis software. The resulting images were printed out on a Hewlett Packard Paintjet™ printer. The average values for percent bond area and the

maximum spacing between adhesive areas in the direction of stretching for Example film materials 1 - 3 are reported herein.

EXAMPLES

A total of 4 sample adhesively-reinforced, uniaxially oriented, low gauge films are set forth below. The sample adhesively-reinforced, uniaxially oriented, low gauge films are designed to illustrate particular embodiments of the present invention and to teach one of ordinary skill in the art the manner of carrying out the present invention.

Example 1

An adhesively-reinforced, uniaxially oriented, low gauge film according to the present invention was made. The film layer contained, on a total weight percent basis based upon the weight of the film, 50% Dowlex® NG3347A linear low density polyethylene having a melt index of 2.3 (grams per 10 minutes at 190 °C) and a density of 0.917 grams per cubic centimeter (g/cc) and 5% Dow® 640 branch low density polyethylene having a melt index of 2.0 (grams per 10 minutes at 190 °C) and a density of 0.922 g/cc. The blend of polyethylene polymers had a melt index of 1.85 (grams per 10 minutes at 190 °C) and a density of 1.452 g/cc. The Dowlex® and Dow® polymers are available from Dow Chemical U.S.A., of Midland, Michigan. The film layer further contained 45% by total weight English China Supercoat™ calcium carbonate ($CaCO_3$) coated with 1% stearic acid, having a 1 micron average particle size and a top cut of 7 microns. The calcium carbonate was obtained from ECCA Calcium Products, Inc. in Sylacauga, Alabama, a division of ECC International. The film formulation was blown into a mono-layer film at a melt temperature of 333 °F (168 °C) to produce a film having an initial unstretched gauge of about 1.5 mils (about 54 gsm). The film was heated to a temperature of about 160 °F (71 °C) and the film was stretch-thinned to about 4.0 times its original length to an effective gauge of about 0.46 mil (about 18 gsm) using a machine direction orientation (MDO) unit, Model No. 7200 available from Marshall & Williams of Providence, Rhode Island, operating at a line speed of 500 feet per minute (152 meters per minute). The film was annealed at a temperature of 215 °F (103 °C). The film was breathable as indicated by the WVTR data set forth in Table I below.

A pattern or network of adhesive areas was applied to a surface of the film, in accordance with the teachings herein. The adhesive was a butene copolymer of atactic polypropylene adhesive available from Rexene Corp. of Dallas, Texas, under the product designation Rextac RT2730. The adhesive was applied to the film layer in the form of randomly dispersed meltblown adhesive fibers, using conventional meltblown apparatus essentially as described in U.S. Pat. No. 4,720,252, the disclosure of which is incorporated herein by reference. The adhesive was heated to about 350 °F (177 °C) and applied to the film at an air temperature of about 430 °F (221 °C), an air pressure of about 20 psig (1.41 kilograms per square centimeter), a forming height of about 3.0 inches (76.2 mm) and a line speed of about 300 feet per minute (91 meters per minute). The adhesive add-on amount was about 1.5 gsm and the maximum spacing of the adhesive areas in the direction of stretching of the film layer was about 0.5 inch (12.7 mm). The average percent bond area was about 18 percent.

Comparative Example 1

The film layer was the same as described in Example 1, with no adhesive areas applied.

Example 2

An adhesively-reinforced, uniaxially oriented, low gauge film according to the present invention was made. The film layer contained, on a total weight percent basis based upon the weight of the film, 45% Dowlex® NG3347A linear low density polyethylene and 55% by total weight English China Supercoat™ calcium carbonate ($CaCO_3$), both as described in detail in Example 1 above. The film formulation was cast into a mono-layer film at a melt temperature of 360 °F (182 °C) to produce a film having an initial unstretched gauge of about 1.5 mils (about 54 gsm). The film was heated to a temperature of about 160 °F (71 °C) and the film was stretch-thinned to about 4.7 times its original length to an effective gauge of about 0.46 mil (about 18 gsm) using an MDO unit as described in Example 1 above operating at a line speed of 500 feet per minute (152 meters per minute). The film was annealed at a temperature of 200 °F (93 °C). The film was breathable as indicated by the WVTR data set forth in Table I below.

A pattern or network of adhesive areas was applied to a surface of the film, in accordance with the teachings herein. The adhesive was a pigmented block-copolymer pressure sensitive adhesive available from National Starch and Chemical Corp., having offices in Bridgewater, New Jersey, under the product designation Dispomelt® NS34-5610. The adhesive was applied to the film layer by first printing the adhesive in a cloud pattern as shown in FIG. 3 hereof to a suitable release paper and then transferring the adhesive to the film layer surface, using a conventional screen printing and transfer process. The adhesive was applied to the release paper at a line speed of about 25-50 feet per minute (7.6-15.2 meters per minute) and the adhesive was transferred to the film layer at a line speed of 300 feet per minute (91 meters per minute). The adhesive add-on amount was about 9.0 gsm and the maximum spacing of the adhesive areas in the direction of stretching of the film layer was about 1.0 inch (25.4 mm). The average percent bond area was about 12 percent.

Comparative Example 2

The film layer was the same as described in Example 2, with no adhesive areas applied.

Example 3

An adhesively-reinforced, uniaxially oriented, low gauge film according to the present invention was made. The film layer and adhesive used was the same as described in Example 2 above. The adhesive was applied to the film layer by first printing the adhesive in a ribbed pattern as shown in FIG. 2 hereof to a suitable release paper and then transferring the adhesive to the film layer surface, as described in Example 2. The adhesive was applied to the release paper at a line speed of about 25-50 feet per minute (7.6 - 15.2 meters per minute) and the adhesive was transferred to the film layer at a line speed of 300 feet per minute (91 meters per minute). The adhesive add-on amount was about 17.0 gsm and the maximum spacing of the adhesive areas in the direction of stretching of the film layer was about 0.25 inch (6.35 mm). The average percent bond area was about 22 percent.

Example 4

An adhesively-reinforced, uniaxially oriented, low gauge film according to the present invention was made. The film and the adhesive used were the same as described above in Example 2, except the adhesive was non-pigmented. The adhesive was applied to the film layer using a Control Coat™ spray adhesive pattern applicator available from Nordson Corp., having offices in Norcross, Georgia, under the product designation Metered Control Coat™ Applicator. The adhesive was heated to about 350 °F (177 °C) and applied to the film at an air temperature of about 380 °F (193 °C), an air pressure of about 80 psig (5.63 kg/cm^2), a forming height of about 1.0 inch (25.4 mm) and a line speed of about 400 feet per minute (120 meters per minute). The adhesive add-on amount was about 2.0 gsm and the maximum spacing of the adhesive areas in the direction of stretching of the film layer was about 0.1 inch (2.54 mm). The average percent bond area was about 15 percent.

Comparative Example 3

A non-breathable film layer was obtained from the film-nonwoven laminate outer cover of a disposable diaper sold commercially by Kimberly-Clark Corporation, the assignee of the present invention, under the product designation Huggies® Ultratrim diapers. No adhesive was applied to this film layer. The film layer had an effective gauge of about 0.41 mil.

TABLE I

	MD TENSILE STRENGTH (grams)	MD PERCENT ELONGATION AT BREAK (%)	CD TENSILE STRENGTH (grams)	CD PERCENT ELONGATION AT BREAK (%)	WVTR (G/M^2/24 hours)
Comp. Example 1	4850	150	830	500	1240
Example 1	6300	162	870	550	
Comp. Example 2	8444	135	698	265	3800
Example 2	6212	101	525	323	3471
Example 3	6800	114	669	427	3827
Example 4	5448	96	585	517	3631
Comp. Example 3	2500	180	840	450	70

The data from Table I clearly illustrate the impact application of adhesive areas as described herein has on the strength and toughness or durability of the film layers alone. Particularly in the cross machine direction, the direction in which uniaxially, machine direction oriented films typically do not have good toughness or durability, the increase in percent elongation at break values as between the virgin films and those same films to which adhesive areas are applied demonstrates the reinforcement function of the adhesive areas.

Finally, the data for Comparative Example 3 establish that the adhesively-reinforced film layers that are incorporated into the film-nonwoven laminate of this invention are at least comparable in strength and toughness to commercially available film layers.

It is contemplated that the adhesively-reinforced, uniaxially oriented, low gauge film constructed in accordance with the present invention will be tailored and adjusted by those of ordinary skill in the art to accommodate various levels of performance demand imparted during actual use. Accordingly, while this invention has been described by reference to certain specific embodiments and examples, it will be understood that this invention is capable of further modifications. This application is, therefore, intended to cover any variations, uses or adaptations of the invention following the general principles thereof, and including such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and fall within the limits of the appended claims.

CLAIMS

What is claimed is:

1. An adhesively-reinforced film comprising:

a film layer having a first surface;

said film layer being oriented in a direction of stretching and having an effective gauge of 0.6 mil or less;

said film layer being formed from a blend including, on a total weight percent basis based upon the total weight of the film layer, from about 30 percent to about 70 percent of a first polyolefin polymer, from about 70 percent to about 30 percent of a filler, and from about 0 to about 20 percent of a second polyolefin polymer;

said film layer having a water vapor transmission rate of at least about 300 grams per square meter per 24 hours;

a pattern of adhesive areas applied to said first surface of said film layer;

said pattern of adhesive areas having an add-on amount of from about 0.1 to about 20 grams per square meter, a percent bond area of from about 5 percent to about 50 percent or less per unit area of said surface of said film layer, and a maximum spacing between adhesive areas in a direction generally parallel to said direction of stretching of about 1.0 inch or less.

2. The adhesively-reinforced film of claim 1 wherein said film has a cross machine direction tensile strength of at least 870 grams.

3. The adhesively-reinforced film of claim 1 wherein said film has a cross machine elongation at break of at least about 300 percent.

4. The adhesively-reinforced film of claim 1 wherein said film has a water vapor transmission rate of at least about 1000 grams per square meter per 24 hours.

5. The adhesively-reinforced film of claim 1 wherein said maximum spacing between said adhesive areas in a direction generally parallel to said direction of stretching is about 0.25 inch or less.

6. The adhesively-reinforced film of claim 1 wherein said maximum spacing between said adhesive areas in a direction generally parallel to said direction of stretching is about 0.125 inch or less.

7. The adhesively-reinforced film of claim 1 wherein said adhesive add-on amount is from about 0.25 to about 5.0 grams per square meter.

8. The adhesively-reinforced film of claim 1 wherein said adhesive add-on amount is from about 0.5 to about 1.5 grams per square meter.

9. The adhesively-reinforced film of claim 1 further comprising an adjacent layer having a surface wherein said adjacent layer is adhesively bonded to said surface of said film layer.

10. The adhesively-reinforced film of claim 1 wherein said first polyolefin polymer comprises a predominately linear polyolefin polymer.

11. The adhesively-reinforced film of claim 13 wherein said predominately linear polyolefin polymer is a linear low density polyethylene.

12. The adhesively-reinforced film of claim 1 wherein said percent bond area is from about 5 percent to about 35 percent.

13. An absorbent article comprising:

a liner;

a backsheet;

an absorbent core disposed between said liner and said backsheet;

said backsheet comprising the adhesively-reinforced film of claim 1.

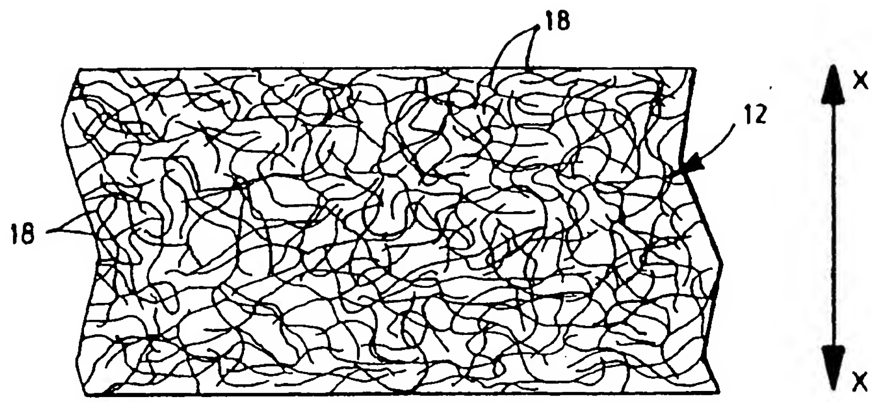

FIG. 1

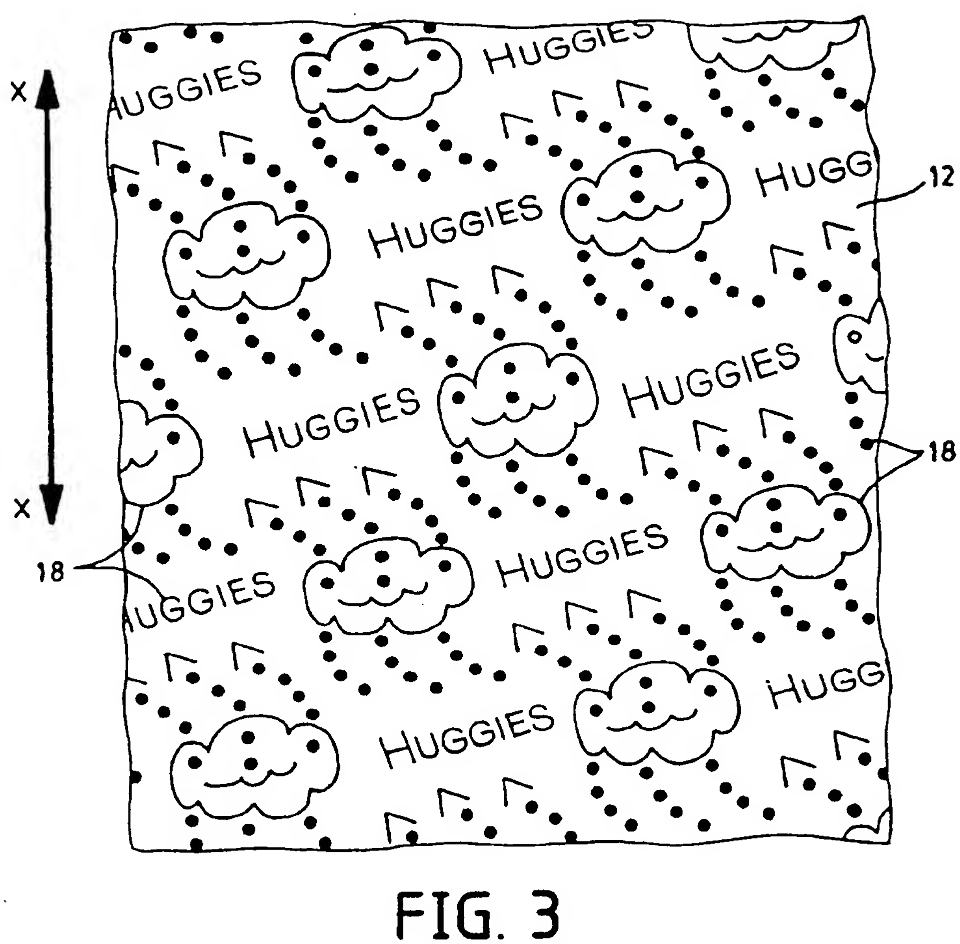

FIG. 3

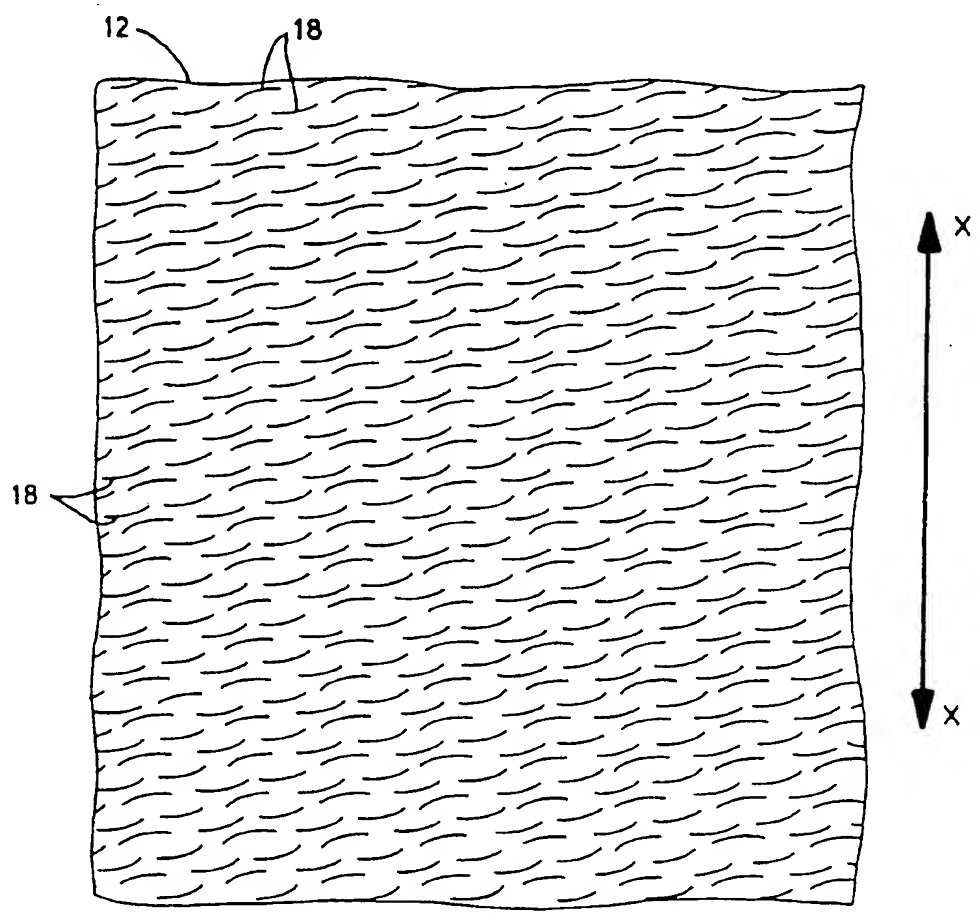

FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 97/12452

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 D04H13/00 A41D31/02 A61F13/00 B32B27/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 D04H A41D A61F B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 691 203 A (KIMBERLY CLARK CO) 10 January 1996 see column 3, line 34 - line 44 see example 1 see column 5, line 6 - line 15 see column 4, line 8 - line 43 ---	1-13
A	EP 0 604 731 A (KIMBERLY CLARK CO) 6 July 1994 see the whole document ---	1-13
A	EP 0 505 027 A (KAPPLER SAFETY GROUP) 23 September 1992 see the whole document ---	1-13
A	WO 95 16562 A (KIMBERLY CLARCK CORP) 22 June 1995 see the whole document --- -/--	1-13

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
1 December 1997	15/12/1997

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

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